# Process Skills-Based E-Module: Impact On Analytical Thinking Skills

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## Abstract

This study aims to determine the E-Module practicum application based on science process skills for high school students on temperature and heat material, describe students' analytical thinking skills, and identify the effect of science process skills on students' analytical thinking. Temperature and heat material skills in physics subjects at school. This study uses a mixed-method with an explanatory design. Data collection was carried out in April-May 2021 at senior high school 10 Muaro Jambi. The population of this study was all students of class X public Senior High School (SMAN) 10 Muaro Jambi. The research sample used was 30 science class students consisting of X science 1, X science 2, and X science 3 SMAN 10 Muaro Jambi. The sampling technique used is random sampling. The instruments used in this study were scientific process skills observation sheets and analytical thinking skills assessment questions. The regression analysis was used to determine how the variables were used. This study obtained the results after students used a practical guide based on science process skills. Students had good science process skills. The science process skill variable affected the students' analytical thinking ability by 52.2%, and other variables influenced the remaining 47.8%. The impact of the research that researchers expect is that teachers can innovate the learning process using e-modules based on science process skills to improve other abilities possessed by students.

**Keywords**: physics education, science process skills, analytical thinking

## INTRODUCTION

Education is a fundamental process for developing and progressing a nation and state. Education is critical in human life and cannot be separated from life itself (Masus & Fadhilaturrahmi 2020; Astalini et al. 2018). Education is a conscious effort to create a learning atmosphere and learning process to actively develop students' potential (Rosnaeni et al. 2018; Astalini et al. 2018). Effective education can make students learn quickly, have fun, and achieve the expected goals (Asyhari & Silvia 2016). Quality education involves actively learning and directs the formation of values that students need in life (Ware & Rohaeti 2018).

One of the values students need to carry out in their daily lives can be formed through science subjects at school because they are closely related to everyday life. Physics is one of the branches of science studied in science subjects at school. Physics is a branch of Natural Sciences (Nadiya et al. 2016; Sumarli 2018; Maulida et al. 2018). Physics is a field of study that studies natural phenomena, and students must understand the concepts that exist in these phenomena (Ratnaningdyah 2017; Hasani

et al. 2019). Physics learning is a field of study where one of the characteristics is hierarchical, meaning that each concept must meet the requirements to understand the previous concept (Kahar 2017). Physics is often considered difficult by middle and high school students (Fatonah et al. 2020). According to students, the difficulty of learning physics is because students cannot process science.

Science process skills are process skills that involve cognitive or intellectual, manual, and social skills (Rahmah et al. 2019). Science process skills can develop students' knowledge (Darmaji et al. 2020; Aldila et al. 2021). Based on Jannah et al. (2018) research regarding the analysis of students' science process skills on the material of temperature and heat, it is known that the results of students' science process skills are sufficient. Difficulties related to temperature and heat have been found in junior and senior high school students, even at the university level (Taqwa et al. 2019). Material temperature and heat are included in sub-temperature and expansion, the heat of temperature change and change of state, black principle, and heat transfer (Lailis et al. 2021). Temperature and heat are learning materials related to everyday life, which can help students live their daily lives.

The 2013 Curriculum and physics material's temperature and heat material have been arranged in KI and KD. In KD grade X SMA in even semesters, namely 3.7, 4.1, and 4.8, it shows the existence of science process skills and students' analytical thinking skills in understanding the concepts of temperature and heat. The ability to think analytically is one of the essential things in education (Prayitno et al. 2017; Syadiah & Admoko 2019). Analytical thinking skills are the ability to analyze a problem by connecting some information so that it can solve the problem (Yuwono et al. 2020). Indicators of analytical thinking skills are distinguishing, connecting, and organizing (Ware & Rohaeti 2018). Analytical thinking skills need to be trained continuously. Analytical thinking ability will usually increase after using problem-solving (Astriani et al. 2018; Sumarni & Kadarwati 2020). Analytical thinking skills are critical to be applied and developed in classroom learning. In this case, if students have higher-order thinking skills, they can solve problems well.

The module is one of the many teaching materials used for teaching. The module is one of the alternative teaching materials that can be developed to support the student learning process (Sumiati et al. 2018). One of the objectives of preparing the module is to provide teaching materials that are in accordance with curriculum guidelines by considering the needs of students (Laila Puspita 2019). The practicum module is a practical implementation guide that contains procedures for compiling, implementing, analyzing data, and reporting (Khairunnufus et al. 2018; Kızılaslan 2019). The existence of the module is still verbal or textual, so students still feel less interested in reading it (Yusro & Sasono 2016; Muslim et al. 2021).

Learning development in Indonesia cannot be separated from the intervention of technological developments. The presence of technology in today's modern era brings changes to life. The development of science and technology is one of the results of human productivity, which has knowledge obtained from the educational process. A teacher must be able to deal with the development of technical education to overcome problems in the learning process (Samsu et al. 2020). With this, a teacher needs teaching materials that are following the demands of the times. In this modern era, teaching materials are required that can be accessed anywhere and anytime. With the development of technology, the current form of the module can be developed in electronic form or commonly referred to as an electronic module (e-module) (Kuswandani et al. 2020).

An electronic module or E-Module is an electronic version of a printed module that can be read on a computer and designed with the required software (Diantari et al. 2018; Halim et al. 2020). The use of e-modules will help students more easily understand learning materials because the development of the learning process is not only reading in a textbook style (Astra et al. 2020; Rahmadhani et al. 2021). In addition to using textbooks to improve analytical thinking skills, it can also be done using suitable learning methods. Following the research of Tipani, A., Toto, T., & Yulisma, L (2019), a STEM-based PjBL model was implemented to improve students' analytical thinking skills. Hasyim, F (2018) research. Conducted to measure analytical thinking and science process skills of prospective physics teacher students at STKIP Al Hikmah Surabaya. In contrast to the study of Yuwono et al. (2020), which states that students' analytical thinking skills have an effect of 53 % on learning outcomes in the realm of knowledge on the subject of movement and style. The position of this study is to determine the application of the E-Module of science process skills to students' analytical thinking skills in physics subjects, especially on temperature and heat materials.

The purpose of this research is to find out how the science process skills of students after using the E-Module for high school physics practicum based on science process skills of high school students on temperature and heat material, how students' analytical thinking skills on temperature and heat material as well as knowing how the influence of science process skills on students' analytical thinking skills on the material of temperature and heat.

## METHODS

This research was conducted using mixed methods. The mixed-methods approach is divided into three types, namely, triangulation design, explanatory design, and exploration design. The mixed-method approach used in this research is an explanatory approach. Descriptive mixed methods design is a combined research method that combines quantitative and qualitative research methods sequentially (Maison et al. 2018).

Data collection was carried out in April 2021 at public senior high school 10 Muaro Jambi, Jambi. The population of this study was all students of class X public Senior High School 10 Muaro Jambi. The population is the generalization area of the research results (Creswell 2007; Jaya 2010; Mendenhall & Sincich 2016). The research sample used was 30 students consisting of X Science Program 1, X Science Program 2, and X Science Program 3 public senior high school 10 Muaro Jambi. The sampling technique used is random sampling. The secondary method is an appropriate and accurate way to determine whether the sample is representative of the population. The goal is that the data obtained can represent the actual population.

In this study, quantitative data used is data on students' science process skills. The students are asked to collect these data, and the question is about how to conduct temperature and heat experiments using the E-Module practicum guide, which is based on science process skills, while the student science process skills contained in the E-Module practicum guide, the indicators are presented in TABLE 1 below.

**TABLE 1**. Student Science Process Skills Assessment Grid

| Science process skill indicators | Number of statements |
|---|---|
| Observation | 4 |
| Classification | 1 |
| Planning an experiment | 2 |
| Doing an experiment | 4 |
| Predict | 1 |
| Making a hypothesis | 1 |
| Size | 1 |
| Create data table | 2 |
| Obtain and process data | 2 |
| Communicate | 2 |
| Experimental Analysis | 2 |
| Conclusion | 4 |

The assessment of students' science process skills uses a Likert scale of 1 to 4, namely: a score of 4 (Very Good), 3 (Good), 2 (Not Good), and 1 (Very Bad).

When the students did the practicum, the researcher assessed the students' science process skills using an observation sheet. After determining the scale, the researcher categorizes the students' science process skills which can be seen in TABLE 2.

**TABLE 2**. Range of scores of students' science process skills

| Range | Category |
|---|---|
| 26.00-45.50 | Very well |
| 45.51-65.00 | Good |
| 65.01-84.50 | Bad |
| 84.51-104.00 | Very bad |

After doing the practicum, students were asked to fill out a questionnaire. The data collected was obtained by distributing a perception questionnaire that was validated by a team of experts. In this study, the questionnaire was in the form of pretest questions to determine students' analytical thinking skills, while the number of social pretest questions given was 15 questions. The assessment of the students' analytical thinking skills questionnaire uses a Likert scale of 1 to 4: a score of 4 (very good), 3 (good), 2 (not good), and 1 (very bad). After determining the scale, the researcher categorizes students' analytical thinking skills, which can be seen in TABLE 3.

**TABLE 3.** Range of scores of quantitative criteria for analytical thinking ability questionnaire

| Range | Category |
|---|---|
| 48.76 – 60.00 | Very well |
| 35.71-48.75 | Good |
| 26.26-37.50 | Bad |
| 15.00-26.25 | Very bad |

Suggestions and criticisms of experts in assessing the practicum modules and experimental devices developed are a form of qualitative data. Qualitative data was used in the form of interviews with several students of class X science 1, 2, and 3 at SMAN 10 Muaro Jambi. Interviews were conducted in a structured and open type. This interview aims to see the direct opinions of students and strengthen quantitative data through the distribution of questionnaires. The qualitative data used by the researcher was obtained through analysis of the results of the perception questionnaire with six questions given. The grid of interview instruments can be seen in TABLE 4.

**TABLE 4.** Grid of Interview Sheet Questionnaire Instruments

| No | Indicator | Statement |
|---|---|---|
| 1 | Science Process Skills | 2 |
| 2 | Benefits of science process skills and analytical thinking | 2 |
| 3 | Effect of science process skills on analytical thinking | 2 |

This study use descriptive and inferential statistics to obtain quantitative data results; as explained (Nasution 2016; Leni Masnidar Nasution 2017), descriptive statistics describe or provide information about conditions or problems using data. Inferential statistics consists of hypothesis testing. Before testing the hypothesis, the data obtained were tested for prerequisites, namely normality and linearity tests, as for the value of the normality test results, which is equal to 0.005. then the data is normal because the data significance value = 0.200 is greater than the minimum data significance value. Then on the linearity test based on decision-making, the data is said to be normal because the data significance value = 0.200 is greater than the minimum data significance value. The significance value is 0.304, more significant than 0.05. So it can be said that the data is linear.

After testing the prerequisites, the data are tested for hypotheses, namely the ANOVA and regression tests. If a Sig value > 0.05 is obtained, it can be concluded that the two variables tested have a significant relationship, whereas if a sig value < 0.05 is received, the two variables tested do not have an important relationship (FIELD 2013; Goos & Maintrup 2015; George & Mallery 2019). Then qualitative data was collected using interviews to complement and strengthen the quantitative data. Qualitative data were analyzed using the analysis proposed by Miles et al. (2013), namely data reduction, data presentation, and conclusion drawing.

The data collection procedure in this study begins with the initial activity. It provided a product in the form of an e-module guide for temperature and heat practicum based on science process skills, followed by students doing practicum using the e-module provided when students do research

practicum assisted by team observing skills. Students' science process using observation sheets. Next, the researchers distributed perception questionnaires and social studies questionnaires for students. After filling out the questionnaire, the researcher analyzed the data using SPSS 25. The quantitative data used descriptive and inferential statistics, while the qualitative data used Miles and Huberman, which generally included data reduction, data presentation, and concluding. The data collection procedure can be briefly seen in the diagram below.

# RESULT AND DISCUSSION

This study includes 2 (two) variables, namely: science process skills (X1) and students' analytical thinking skills (X2), which aims to find out how science process skills variables have a direct and positive effect on students' analytical thinking ability variables. Science process skills are used as activities to improve students' psychomotor aspects. This study involved 28 students of class X Science Program SMA Negeri 10 Muaro Jambi. This observation is based on 12 indicators of science process skills, which consist of basic and integrated science process skills. The number of statements on the student's science process skills observation sheet consists of 26 statements. The results of the research on the mastery of students' science process skills on the material of temperature and heat are shown in TABLE 5 below.

**TABLE 5.** Result Data Description of students' scientific process skills on the material of temperature and heat

| Range | F | % | Category | Means | Median | Mo | Max | Min | Std. |
|---|---|---|---|---|---|---|---|---|---|
| 26.00-45.50 | 0 | 0 | Very Not Good | | | | | | |
| 45.51-65.00 | 0 | 0 | Not good | 83.8214 | 85.00 | 82.00 | 97.00 | 68.00 | 6.8915 |
| 65.01-84.50 | 13 | 46.4 | Good | | | | | | |
| 85.51-104.00 | 15 | 53.6 | Very well | | | | | | |

Based on the description of students' science process skills, data from 28 student respondents of SMAN 10 Muaro Jambi showed that the maximum, minimum, and mode scores were 97.00, 68.00, and 82.00, respectively. In addition, 53.6% of students have excellent science process skills, and the remaining 46.5% have good science process skills. The instrument consists of 12 indicators: observation, classification, communication, measuring, predicting, making hypotheses, designing experiments, analyzing experiments, conducting experiments, collecting and processing data, creating tables, and making experimental conclusions. Each indicator used has a different statement.

After knowing the students' science process skills, the students' analytical thinking skills was observed. This research was conducted based on three indicators of students' analytical thinking abilities. The number of statements on the student's analytical thinking ability observation sheet consists of 15 statements. The research results on students' analytical thinking skills on the material of temperature and heat are shown in TABLE 6 below.

**TABLE 6.** Result Data Description of students' analytical thinking skills

| Range | F | % | Category | Means | Median | Mo | Max | Min | Std |
|---|---|---|---|---|---|---|---|---|---|
| 48.75-60.00 | 16 | 57.14 | Very well | | | | | | |
| 37.51-48.75 | 12 | 42.86 | Good | 50, 5714 | 49.5 | 46 | 58 | 45 | 4.62724 |
| 26.2-37.50 | 0 | 0 | Not good | | | | | | |
| 15.00-26.25 | 0 | 0 | Very Not Good | | | | | | |

Based on the description of the data obtained from 28 student respondents of SMAN 10 Muaro Jambi, it can be seen that the maximum, minimum, and mode scores are 58, 45, and 46, respectively. In addition, 57.14% of students have excellent analytical thinking skills, and the remaining 42.86% have good analytical thinking skills. The mean value is 50.57, the median value is 49.5, the mode value is 46, the maximum value is 58, and the minimum value is 45.

Inferential statistical results were obtained through simple linear regression analysis. To use path analysis in regression testing, it is necessary to carry out statistical prerequisite testing procedures on the data first. If all requirements are met, it can proceed with path analysis. The needs analysis test goes through 2 (two) stages: 1) Normality Test and 2) Linearity Regression Test. Testing the normality

requirements of each variable is carried out to determine whether the distribution of data from each variable does not deviate from the characteristics of normally distributed data. The normality test results that can go through the normality analysis of the Kolmogorov-Smirnov test are in accordance with the reference for decision making. Namely, the data can be said to be normal if the data significance value is more significant than 0.005. Based on this decision, the data is said to be normal because the data significance value = 0.200 is greater than the minimum data significance value. Then proceed with the last condition that must be met in conducting path analysis, namely linearity. When viewed from the significance (sig) of the ANOVA test to determine the results of the linearity test, based on the output results obtained a significance value of 0.327, which is greater than 0.05. So it can be said that there is a linear relationship

After the data were tested for normality and linearity, and it was proven that the data were normally and linearly distributed, then a regression test was performed. The results of the regression test can be seen in TABLE 7 below.

TABLE 7. Data The results of the regression analysis of student's analytical thinking skills and scientific processes

| Model | Signature | R | R Square | Adjusted Square |
|---|---|---|---|---|
| (Constant) | .000 | 0.723 | 0.522 | 0.529 |
| Analytical Thinking | .034 | | | |
| A. Dependent Variable: Scientific Process Skills | | | | |

Based on TABLE 7, the significance value is 0.034, which is smaller than the probability value. Where 0.034 is smaller than 0.05, then H0 is rejected, and Ha is accepted. It can be concluded that there is an influence of science process skills on students' analytical thinking abilities. The correlation value (R) is 0.723, and the coefficient of determination is obtained from the square of the R-value. Other variables influence it.

In addition to quantitative data, the researcher also conducted interviews with several respondents to obtain qualitative data. The results obtained during the interviews were primarily positive for various reasons. Here are the results of a consultation with one of the students:

1. Do you agree that students should have good science process skills?
   The student answers: *"Yes, of course."*
2. *Can science process skills help you learn?*
   The student answers: *"Yes, because it gives me more skills to learn."*
3. *Is science process skills-based learning interesting?*
   The student answers: *"Yes, because in it, I get knowledge about ways to solve problems that I did not know before."*
4. *Can science process skills-based learning improve your analytical thinking?*
   Student answers: *"Yes, because the more I know."*
5. *Is learning using science-based learning process skills clear?*
   The student answers: *"Yes, science process skills-based learning is straightforward to understand."*
6. *Is the science process skill-based learning provided can be a complement to the learning method in learning physics.*
   The student answers: "Yes".

Based on the results of interviews that have been conducted, it can be concluded that students responded positively to the learning of temperature and heat practicum based on science process skills. Respondents said that in terms of attractive appearance and multimedia selection was appropriate. In addition, respondents also mentioned that the existence of science process skills-based learning could make the learning process easier and more effective. Furthermore, respondents said that this effect was due to the selection of materials and the language used in Indonesian. Respondents also noted that the temperature and heat practicum based on science process skills could awaken and improve students' analytical thinking skills. In addition, it can be seen that there is an influence of science process skills on students' analytical thinking skills through the ability to increase students' analytical thinking,

which can be seen from students' activeness and interest in practical learning based on science process skills.

Observations of physics learning in the field show that physics learning carried out by teachers is not following the 2013 curriculum, and information is obtained that physics learning has not been taught in an integrated manner. The skill of teaching physics is different from the skill of teaching other subjects. Physics learning should contain scientific content that includes various facts, concepts, laws, and theories. Science process skills are processes in carrying out science-related activities (Desnita & Susanti 2017; Athiyyah et al. 2020). The students' science process skills was seen based on the results of statistical analysis conducted by researchers. The results showed that students' abilities to complete temperature and heat practicum based on science process skills had good skills. This can be seen through the analysis of good science process skills, as many as 53.6% of students have excellent science process skills, and the remaining 46.5% have good science process skills. The absence of students who get a lousy percentage on science process skills can complete it, so students of SMAN 10 Muaro Jambi indeed have good science process skills. These science process skills can be further improved through a learning process that is designed in such a way and using learning support devices (Solihan et al. 2018; Haryadi & Pujiastuti 2019; Diana et al. 2019).

Furthermore, the results obtained showed that students have good analytical thinking skills. This can be seen from the results of the SPSS test that 57.14% of students stated that their analytical thinking ability was excellent, and the remaining 42.86% said their analytical thinking ability was good. The low analytical thinking ability can be caused by the learning process that does not stimulate students. To improve analytical thinking skills, students must get used to solving analytical problems (Ilma et al. 2017; Rosadi et al. 2018; Laila et al. 2019). Before the regression model is used to test the hypothesis, the assumption is first tested. If the assumption test used is the normality and linearity test. Based on the basis of decision-making on the normality test, it is said that the data used by the researcher is normal because the data significance value = 0.200 is greater than the minimum significance value, namely 0.05 data. While the linearity test based on the output results obtained a significance value of 0.327, which is more significant than 0.05, the data is said to be linear.

After the data used by the researcher passed the assumption test and was declared normal and linear, the influence hypothesis was tested using regression testing. In predicting and measuring the value of the influence of one variable (independent/independent/predictor) on other variables (autonomous/dependent/response), a regression test can be used (Yuliara & I Made 2016). Based on the regression test conducted by the researcher, the significance value was 0.034, which was smaller than the probability value. Where 0.034 is smaller than 0.05, then H0 is rejected, and Ha is accepted. So that there is an influence of science process skills on students' analytical thinking skills, in other words, if students have good science process skills, then these students also have good analytical thinking skills.

The researcher's quantitative data was strengthened through qualitative data obtained through interviews with students. It can be concluded that students stated that there was an influence between science process skills and analytical thinking skills after using the temperature and heat practicum guide e-module based on science process skills. The e-module used by students can grow and improve their scientific process skills and analytical thinking skills. The research results support the results of research by Royani et al. (2018), which states that there is an influence of students' science process skills on students' analytical thinking abilities.

The advantages of this research can be seen from research (Ningsi et al. 2021) which developed an Electronic Practicum Guide Based on Science Process Skills on Temperature and Heat Materials. Still, in this study, the researcher used a practical guide based on science process skills associated with variables thinking ability student analysis. According to previous research by Aldila (2021), which analyzes students' science process skills only, in this study, the researcher used an additional variable, namely analytical thinking ability, which became the dependent variable in the study. Research by Ilma, R et al. (2017). This is to determine the profile of analytical thinking on students' algebra problems in terms of visualizer and verbalizer cognitive styles. This research was conducted to analyze analytical thinking skills in physics subjects with high school research subjects based on previous research.

The recommendation for other researchers is that the research conducted in this study only reveals a small number of problems related to scientific process skills and analytical thinking. In this case, there are still many factors that can affect the science process skills and students' analytical thinking skills and have not been revealed in this study. For this reason, it is recommended for future researchers who are interested in conducting further studies or research so that they can be carried out better. Researchers also provide recommendations for further research to conduct a broader range, add other variables, and expand the scope of study in their research.

By doing this research, it is expected to provide information to teachers as educators to know that implementing e-modules based on science process skills can improve science process skills. With this research, the teacher can also know the students' scientific process skills and analytical thinking abilities so that it can be a benchmark or benchmark for teachers to see students' scientific process abilities and students' analytical thinking abilities. So that in teaching and learning activities, teachers can adjust students' needs by varying learning methods and models so that learning that takes place in schools can improve students' science process skills and students' analytical thinking.

## CONCLUSION

Based on the research conducted, the description of students' science process skills, 53.6% of students have very good science process skills and the remaining 46.5% have good science process skills. On the analytical thinking ability variable, 57.14% of students have very good abilities, and the remaining 42.86% have good analytical thinking skills. In the class studied, science process skills also affected students' analytical thinking skills at 52.2%, and other variables influenced the remaining 47.8%. This means that students with good science process skills will also have good analytical thinking skills and those who do the opposite. The educational implications of the results of this study indicate that the variables of science process skills affect students' analytical thinking abilities. However, other factors such as motivation to learn and the character of liking to read affect the level of analytical thinking, which are not included in this study.

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